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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Effect of Heat Treatment on Germination of Alkali Sacaton[1]

O. D. Knipe[2]

A small percentage of alkali sacaton *(Sporobolus airoides)* seeds germinate after heating at 121° C; none germinate after heating at higher temperatures. Imbibition is reduced by heating at 65°C; after imbibition no germination occurs if seeds are imbibed and heated at 60°C on 7 or more successive days.

Keywords: Seed germination, *Sporobolus airoides*.

Summer midday soil-surface temperatures in the Southwest frequently range between 60° and 65° C.[3] Attempts to establish grasses in the area by seeding are usually unsuccessful. It seems possible that such high temperatures may contribute to the failure of grass seeds to germinate.

Cartledge et al. (1936), Davis (1947), and Siegel (1953) reported that survival increased with decreasing moisture content of heat-treated seeds, and that heating delayed germination and produced other phenotypic as well as genotypic effects.

Capon and Van Asdall (1967) found that several desert annual seeds stored at 167°F (75° C) for 4 weeks failed to germinate, and that continued storage beyond 4 weeks at 122° F (50° C) progressively diminished germinability.

[1]*Research reported here was conducted in cooperation with the Bureau of Land Management, U.S Department of the Interior.*

[2]*Associate Plant Ecologist, Rocky Mountain Forest and Range Experiment Station, with central headquarters at Fort Collins in cooperation with Colorado State University. Research reported here was conducted while the author was assigned to Albuquerque, New Mexico: he is now located at the Station's field unit in Tempe, in cooperation with Arizona State University.*

[3]*Unpublished data in the files of the Rocky Mountain Forest and Range Experiment Station, Albuquerque, New Mexico.*

The purpose of this study was to determine if heat treatment reduces the germinability of dry and water-imbibed seeds of alkali sacaton (*Sporobolus airoides*).

Methods and Materials

Since germination of alkali sacaton seeds varied considerably with size (Knipe 1970), two sizes of seeds (size 1 — large, measuring 1.5 x 1 mm, and size 3 — small, measuring 1 x 0.6 mm, all air-dried) were used.

The research consisted of five distinct tests as follows: (1) Dry seeds subjected to 71°C for 15 minutes, 30 minutes, 1 hour, 3 hours, and 6 hours, (2) dry seeds subjected to 54° and 65°C for 6 hours daily for up to 12 days, (3) dry seeds subjected to successively higher temperatures for increasing time periods until temperatures which preclude germination were reached, (4) seeds imbibed for successive time periods and subjected to heat treatments of 65° and 71°C, and (5) seeds imbibed for 24 hours and subjected to heat treatments of 60°C for 1 hour on successive days.

After heat treatment, the seeds in each study were germinated in darkness at constant 32°C, conditions shown previously to be optimum for germination of alkali sacaton (Knipe 1967, 1969). Each study consisted of four 100-seed

replications germinated in 11 cm diameter petri dishes on two thicknesses of standard blue germination blotter paper moistened with 18 ml distilled water. Percentage germination was determined after 72 hours, but the seedlings were observed for 14 days to determine if heat treatment resulted in abnormal seedlings. Unheated check samples were germinated simultaneously for comparison with heat-treated seeds. A seed was considered germinated when its radicle and plumule had attained a length of 1 mm. The seeds used in the study were collected within the Rio Puerco watershed area of west-central New Mexico. The seeds were a 2-year-old lot that were hand collected, cleaned, and stored in cloth bags under laboratory conditions.

Results and Discussion

Effect of maximum natural temperature on dry seeds.—Treatment of dry seeds for up to 6 hours at 71°C had no apparent effect upon either germination or seedling normalcy.

Effect of recurrent maximum natural temperature on dry seeds.—Heat treatments of 54° and 65°C for 6 hours daily for up to 12 days had no apparent effect on germination or seedling normalcy of dry size 1 or size 3 seeds.

Maximum tolerable temperature.—Germination of dry size 1 seeds was not reduced at temperatures lower than 121°C (table 1). Although only a small percentage of seeds treated at 121°C germinated, the seedlings appeared normal. Seeds heated at 135°C, regardless of duration of exposure, failed to germinate.

These results show that dry alkali sacaton seeds are remarkably well adapted to survival under temperature extremes far in excess of those likely to occur in nature.

Effect of maximum natural temperature on imbibed seeds.—Size 1 seeds imbibed 24 hours or less in distilled water before treatment of 65°C for 1 hour germinated as well as unimbibed and nonheat-treated seeds. However, longer imbibition before heat treatment reduced germination considerably with no germination obtained for seeds imbibed more than 40 hours. Size 3 seeds responded similarly but germination percentages were lower.

The effect of heat treatment of 71°C after imbibition was greater than 65°C and greater on size 3 seeds than on size 1 seeds (table 2). Heat treatment of 71°C after only 4 hours' imbibition reduced germination of size 3 seeds, while 8 hours was required to reduce germination of size 1 seeds.

Table 1.--Percent germination of size 1 alkali sacaton seeds subjected to various periods of pregermination heat treatment

Pre-germination temperatures (°C)	Germination by preheating periods				
	10 min	30 min	1 hr	3 hr	6 hr
	- - - - - *Percent* - - - - -				
None (check)			98		
38	95	97	98	100	100
46	99	98	98	97	98
54	97	98	95	99	96
63	98	98	99	99	98
71	96	98	98	96	96
79	88	89	95	95	96
93	85	92	98	97	97
107	89	96	89	92	96
121	8	12	6	2	1
135	0	0	0	0	0

Table 2.--Percent germination of size 1 and 3 alkali sacaton seeds subjected to various pregermination temperatures for 1 hour after various periods of imbibition

Time imbibed prior to heating (hr)	Germination by--			
	Seed size 1		Seed size 3	
	65°C	71°C	65°C	71°C
	- - - *Percent* - - -			
None (check)	97		82	
4	98	96	84	62
8	100	80	84	42
12	94	63	84	30
16	92	63	83	32
20	94	28	80	26
24	96	28	76	9
28	40	0	48	0
32	42	0	43	0
36	7	0	6	0
40	10	0	10	0
44	0	0	0	0
48	0	0	0	0

It should be noted that approximately 50 percent of the size 1 seeds had sprouted by 28 hours after the start of imbibition, while only 10 percent of size 3 seeds had sprouted after 32 hours.

The reductions were in all instances greater than the number of sprouts present; obviously growth processes within the seeds were severely affected as were those of seeds which showed signs of sprouting. It is also obvious that there was a point in the within-the-seed growth stage at which damage occurred at 71°C and not at 65°C.

Effect of usual natural temperatures in imbibed seeds.—The results of the first three tests showed that dry seeds of alkali sacaton are not damaged by temperatures that are likely to occur in nature. Test 4 showed that heat treatment at 65°C after 28 hours' imbibition reduced germination, and after 40 hours' imbibition, killed the seeds. Since these conditions represent the extremes that are likely to occur in nature, Test 5 was designed to determine the effect of conditions more likely to occur in nature. Size 1 seeds were imbibed for 24 hours and subsequently subjected to heat treatment for 1 hour at 60°C each day for 1 to 8 days. Treatment for 3 days reduced germination slightly, and germination was consistently reduced further by each successive day of treatment. There was no germination after 7 days of treatment. Thus, alkali sacaton seeds are killed by recurrent wetting and drying under conditions that can be expected to occur in nature.

The mechanism responsible for reduction in germination percentage due to heat treatment was not determined. It is the opinion of the author that the heat-treated seeds that failed to germinate were dead. Years of experience in germination testing of the species has shown that viable seeds of the species will germinate under the conditions maintained in these studies. It is possible, however, that heat treatment alters the seedcoat (e.g. hardening) or the germination mechanism in such a way that the seeds remain viable while requiring some special procedure (e.g., scarification) to stimulate germination.

Conclusions

Dry seeds of alkali sacaton can withstand, without loss of viability, temperatures in excess of 110°C which exceed any likely to occur naturally.

Percent germination of large seeds of alkali sacaton imbibed for 8 hours were reduced by heat treatment of 71°C for 1 hour; percent germination of small seeds imbibed for only 4 hours was reduced by such heating. Both large and small seeds must imbibe for 24 hours before germination percentage is appreciably reduced by heat treatment of 65°C.

Temperatures no higher than those which frequently occur the day following a summer rain prevented germination of imbibed seeds; this could account for the naturally poor field germination of alkali sacaton during the summer.

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Agriculture—CSU, Ft. Collins